Department of Biochemistry
University of Washington
School of Medicine

Self-Study 2008

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Department of Biochemistry Self-Study

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Section A. General self-evaluation

Note: Alan Weiner became the first outside chair of the department beginning in August 2000; Richard Palmiter had been acting chair for the previous year, and Kenneth Walsh chair before that (1992-1999). Although much has changed since August 2000, much remains the same, and this Program Review treats August 2000 as the boundary between the past and present.

A1. What are your unit's strengths? Units generally have a variety of roles and responsibilities within the institution. Please describe what you do, focussing particularly on those things you do well.

Strengths. The greatest strength of the department is doing so many different things well. Nearly all of our faculty think of themselves as having multiple identities as researchers, mentors, and classroom teachers, and though the balance clearly tilts toward research and the associated mentorship, classroom teaching is never far behind. In both research and teaching, our faculty pride themselves on breadth, depth, and integration:

A1a. **Intellectual diversity.** The research in our department covers many diverse fields (structural biology, developmental biology, cell and molecular biology, genetics, computational biology, gene therapy, infectious disease, drug design and vaccine development) yet our faculty remain unified. The diversity of interests has not led to conflict or competition between the usual affinity groups (structural and computational biology, developmental biology, molecular biology, and more classical biochemistry) but rather to a deliberately interdisciplinary spirit, and a determination to hire new faculty who share our view that mutual interests and collaborations can and should be cultivated both within and outside the department. Indeed, this is why all five of our junior faculty searches since 2000 have been untargeted (see section A6); a good personal and intellectual fit is just as important as individual excellence.

A1b. **Teaching responsibilities.** Our departmental teaching obligations cover the entire range from introductory undergraduate biology (BIO 200, "Molecular, cellular, and developmental biology"); a two quarter introductory biochemistry series for nonmajors (BIOC 405 and 406); a three quarter introductory biochemistry series for majors (BIOC 440, 441, and 442); an introductory biochemistry laboratory (BIOC 426, taught both fall and spring); a two quarter introductory biochemistry series for first year medical students (Human Biology or HUBIO 514 and 524); and introductory biophysical approaches to macromolecular structure (BIOC 530, "Advanced biochemistry"). We also teach a number of conjoint graduate courses such as CONJ 538 ("Genetic instability and cancer") and CONJ 541 ("Molecular biology of cellular processes") where "conjoint" indicates faculty from more than one department. In addition, we teach many occasional half quarter minicourses (called BIOC 533a/b for molecular biology and biochemistry, BIOC 534a/b for biophysics or structural biology) covering topics as diverse as Functional genomics; Signal transduction in vascular biology; RNAi, miRNAs, and siRNAs; Symmetry in biological systems; Hemostasis; Transcriptional regulation; Topics in structural biology of malaria; and NMR methods. All of these courses are taught by regular faculty actively engaged in research. The faculty take their teaching obligations very seriously, and no faculty member or graduate teaching assistant would ever doubt for a moment that we practice what we preach: We value and expect good teaching, we praise it, and we do it gladly.

A1c. **Public service.** We also provide significant public services, from the mundane (but essential) to the highly sophisticated, both here at UW and around the world:

A1c1. The **Yeast Resource Center** (http://depts.washington.edu/yeastrc/) is funded by the NIH National Center for Research Resources (NCRR) with Professor Trisha Davis as Principal Investigator. The mission of the Yeast Resource Center (YRC) is to facilitate the identification and characterization of protein complexes in the budding yeast *Saccharomyces cerevisiae*. The YRC provides expertise and access to five advanced technologies: mass spectrometry (John Yates of Scripps and Mike MacCoss of UW); yeast two-hybrid arrays (Stan Fields of UW); deconvolution fluorescence microscopy (Trisha Davis and Eric Muller); protein structure prediction (David Baker); and computational biology (Bill Noble of UW). These critical but costly technologies are made available on a collaborative basis to researchers throughout the US. The ultimate goal of the YRC is a complete understanding of the chemical interactions required for the maintenance and faithful reproduction of a living cell. The conservation of fundamental biological processes from yeast to humans ensures that this knowledge will shape and advance our understanding of all living systems.

A1c2. The **UW Cryo EM Facility** (http://cryoem.washington.edu/) also known as the Laboratory of Molecular Electron Microscopy. The Department of Biochemistry, together with the University, School of Medicine, Washington Research Foundation, and the Murdock Charitable Trust have all invested heavily in establishing this facility. Under the direction of Assistant Professor Tamir Gonen (section A2), the facility will benefit the large, interdepartmental, and interdisciplinary community of UW faculty who work on large protein complexes or membrane proteins including: a multitude of ion channels (Departments of Pharmacology, Physiology and Biophysics); Toll-like receptors or TLRs (Immunology and Biological Structure); bacterial and host membrane proteins that play a role in *Salmonella* infection and cystic fibrosis (Microbiology and Medicine); the complex of frizzled, LRP5, and LRP6 proteins (low density lipoprotein receptor-related proteins 5 and 6) that function as coreceptors in the Wnt signalling pathway (Biological Structure and Pharmacology); rhodopsin, the first G-coupled protein receptor for which the structure was in fact determined by Dave Teller and Ron Stenkamp in our department (Biochemistry); the role of BRCA1 in ubiquitination and cancer (Biochemistry, Pharmacology, and Genome Sciences); dystroglycans, which as key membrane anchors for muscle fibers are directly relevant to the cause and potential cure of muscular dystrophy (Neurology and Biochemistry); telomerase and ribonucleoprotein structure (Chemistry and Biochemistry); analysis of large protein complexes (Genome Sciences, and the NCRR-funded Yeast Resource Center directed by Trisha Davis of Biochemistry); and the role of the lipid environment and prenylation in membrane protein function (Chemistry and Biochemistry).

The facility will have three microscopes, each serving a different purpose. The 100 kV FEI Morgagni noncryo EM has a tungsten filament for high contrast imaging, a nontiltable stage, and a small CCD for initial specimen examination and teaching purposes. The 120 kV FEI Tecnai EM has a tiltable cryo stage, and a lanthanum hexaboride filament (LaB_6) providing bright, coherent illumination for initial low resolution data collection as well as more advanced teaching purposes. The 200 kV FEI Tecnai EM also has a tiltable cryo stage, but the field emission gun (FEG) and higher voltage provide even greater coherence for high resolution data collection. The 120 and 200 kV scopes will be housed in the UW Cryo EM Facility currently under construction in the basement of J-wing ("–1 level") contiguous with all other basic science departments in the School of Medicine; the 100 kV scope is already installed and functioning on the 3rd floor of J-wing next to the Gonen wet lab and computational facility.

An interdepartmental Oversight Committee will ensure that the UW Cryo EM Facility is responsive to regional, institutional, local, and individual needs. Professor Alan Weiner (Chair, Biochemistry) will serve ex officio, but the other members will be major users with competence in cryo EM: Assistant Professor Tamir Gonen (facility director, Biochemistry); Professors Wim Hol (Biochemistry and Biological Structure), Rachel Klevit and David Baker (Biochemistry), Gabriele Varani (Chemistry and Biochemistry), Samuel Miller (Microbiology); and Associate Professors Wenqing Xu (Biological Structure) and Ning Zheng (Pharmacology). The financial goal of the facility is to become self-sustaining, and free of departmental subsidy, within the first two years of operation through a combination of user fees, R01, and P01 support.

A1c3. **Biochemistry Stores** is one of only two locations on campus (Chemistry Stores is the other) where a bench scientist can get another vial of *Bam*HI restriction enzyme, or individually wrapped 10 ml disposable pipettes, without waiting for a local or overnight delivery. Supervised by Mr Leo Alcantara, Biochemistry Stores moves about $2,000,000 of inventory yearly and is operated as a "recharge" center, i.e. "profits" are forbidden by federal law, but losses become the responsibility of the department. To date we have operated without experiencing a loss, but administration and staffing of Stores are a significant additional responsibility. We should also stress that our customers come from nearly every department in the Health Sciences Complex, and we view the continued operation of Biochemistry Stores as an essential service to biomedical researchers throughout the School of Medicine.

A1c4. **DNA Sequencing Facility** (http://depts.washington.edu/biowww/dna/index.html) is another recharge center which provides rapid turnaround for the multitude of small sequencing jobs required by modern molecular biology and recombinant DNA work. Supervised by Ms Lekha Devarayalu, the facility began small in 1996 with a single ABI 377 sequencer, but today serves a clientele of over 150 Principal Investigators with about 600 individual users from the School of Medicine, the College of Arts and Sciences, as well as Childrens' Hospital and Harborview Hospital. To meet new demand in a timely fashion, the facility took out a low interest state loan to purchase an ABI 3730XL high-throughout capillary DNA Analyser. The facility processes about 2000 samples a week (over 100,000 annually) with a turnaround time of 2 to 3 business days; the electropherogram and sequence outputs are made available in PC and Mac format on the facility server; and prices have been slashed 4 times in the past 7 years. This facility is designed for the convenience of occasional to moderate users; it does not offer the massive, high throughput sequencing in 386 well plates required for serious genomic studies.

A2. How do you measure the success of your unit as a whole? What teaching, research and service performance criteria are typical in your field? Which units nationally do you consider to be your peers along these dimensions?

What's in a name? Some 6 years ago, NIH listed our department as the third best funded Department of Biochemistry in the nation with awards totalling $18,363,542. We came in just behind Johns Hopkins and Stanford ($19M each) and just ahead of Baylor ($17M), University of Pennsylvania ($16M), and University of Texas Southwestern ($16M). We always welcome good news, but this was surprising as we have many large, prosperous, and highly productive peer departments at public and private universities across the country. The explanation turned out to be that the vast majority of "biochemistry" departments had amalgamated with other departments ("Department of Chemistry and Biochemistry" at UC Boulder, "Department of Biochemistry and Biophysics" at Oregon State, "Molecular Genetics and Biochemistry" at University of Pittsburgh; "Molecular Biophysics and Biochemistry" at Yale, "Biochemistry and Molecular Biology" at Harvard, "Biochemistry, Molecular and Cell Biology" at Cornell) or had decided that "biochemistry" was too shopworn a name and should be changed to something trendier (for example, "Biomolecular Chemistry" at UW Madison; or the "Division of Biochemistry and Molecular Biology" within the "Department of Molecular and Cell Biology" at UC Berkeley).

We are not the only department of our kind that is confused about our research scope and limits. Once upon a time, a biochemistry department could be defined by a presence in structural biology (NMR and X-ray crystallography) but no longer; these disciplines can also be found here at UW in Biological Structure, Pharmacology, Medicinal Chemistry Chemistry, Physiology and Biophysics. Similarly, enzyme mechanisms and kinetics were part of biochemistry, but are now found here at UW in Chemistry, Microbiology, Bioengineering, and Chemical Engineering. And developmental biology, which used define biology departments, is now found in every major basic science department here at the medical school including Biochemistry, as well as in the Department of Biology (recently reconstituted from the daughter Departments of Zoology and Botany).

A working definition of biochemistry. Perhaps a modern department of biochemistry should be defined not in terms of traditional (or evolving) subdisciplines but as a department that focusses on the molecules that carry out biological processes, but without ever losing sight of the processes as a whole. Thus the question is not whether yeast chromosome structure would fit into the department, but whether a geneticist is likely to pursue the key questions to the level of specific molecules; not whether zebrafish is a good developmental system, but whether the study of melanophores in the regenerating tail will become molecular or remain genetic or cell biological. Admittedly these blurry boundaries are hard to define, but a focus on molecules may be part of the glue that holds our diverse interests together.

A second consideration in deciding who to hire and how to grow is to ask not what the new faculty member will do for the department alone, but what strengths the new faculty member will also bring to the School of Medicine as a whole (as well as Upper Campus). Our three most recently hired faculty all reflect this guiding principle:

• **Brian Kennedy**, who was hired in 2001 and recently promoted to Associate Professor with tenure, works on aging in eukaryotes from yeasts to humans, and on the role of mammalian lamins in maintenance of the differentiated state. His work on aging fits beautifully into a long tradition here at UW, beginning with George Martin (Pathology) and continuing in many guises and departments, most prominently in the Nathan Shock Center of Excellence in the Basic Biology of Aging under the direction of Peter Rabinovitch (Pathology); and an Ellison Medical Foundation Award for $2,000,000 over 5 years with Kennedy as Principal Investigator to build "A consortium for the determination of public pathways regulating longevity" in yeast, worms, and mice. Kennedy's work on lamins fits equally well into a long tradition of studies of muscular dystrophy both here at UW (Steve Hauschka, Jeff Chamberlain, Stan Froehner, and others) and at the Fred Hutchinson Cancer Research Center ("the Hutch") (Steve Tapscott and others) culminating 3 years ago in formation of the Wellstone Muscular Dystrophy Research Center (http://depts.washington.edu/mdcrc/committee.html).

• Assistant Professor **Alex Merz**, who joined the department in 2004, works on vesicle trafficking in yeast and mammalian cells. Merz recognized during his first interview that UW was an unusually collaborative research environment, and that his interests in novel optical assays, nanotechnology, and single molecule techniques would flourish here; he quickly established working relationships with faculty in Chemistry, Biology, and Physiology and Biophysics.

• Most recently, Assistant Professor **Tamir Gonen**, an X-ray crystallographer turned cryoelectron microscopist, joined the department in 2005. Although UW is strong in the two traditional methods of protein structure determination, X-ray crystallography and NMR, neither of these powerful methods can be used to study very large protein complexes or membrane proteins embedded in native biological membranes. Cryo EM can transcend these limitations, and Gonen has the breadth, balance, vision, and leadership ability to design and direct the UW Cryoelectron Microscope Facility currently under construction in the basement of J-wing (section Ac2). This facility will benefit the many investigators in our large, interdisciplinary, and highly collaborative biomedical community — including faculty in the Departments of Biochemistry, Pharmacology, Biological Structure, Physiology and Biophysics, Microbiology, Immunology, Neurology, Medicinal Chemistry, and Chemistry — who work on membrane proteins and large protein complexes. Groups at the Hutch and the Institute for Systems Biology (ISB) have also expressed an interest.

Metrics for success. The most obvious metrics are teaching evaluations and external research funding.

• The College of Arts and Sciences maintains an elaborate Instructional Assessment System (IAS) within the Office of Undergraduate Affairs, and distributes an evaluation form (Appendix I) with 31 pointed questions ranging from "Instructor's Effectiveness and Enthusiasm" to "Clarity of student responsibilities and requirements"; the form also asks students to compare the "Intellectual Challenge" of the course to others, and to indicate their own "Level of Involvement." Our faculty consistently rank high compared to others in a university committed to good teaching. The IAS evaluates all our courses except, as described in the next paragraph, Human Biology (HUBIO) 514 and 524 taught for medical students.

• In the School of Medicine, the Course and Instructor Evaluation System administered by the Department of Medical Education and Biomedical Informatics

(MEBI) evaluates all Human Biology course offerings and the faculty who teach them. Courses are evaluated every year, using a core set of questions; and every other year, each course is subjected to a deeper course-specific evaluation designed by MEBI faculty with help from the medical students. MEBI evaluates our Human Biology (HUBIO) 514 and 524 for medical students, but none of our undergraduate or graduate courses.

• This past year, faculty with primary appointments in Biochemistry (i.e. not including joint appointees with primary appointments in other departments) were awarded roughly $20,000,000 in total direct costs from external sources for research support. Accounting for this total were $11,600,000 from NIH, $389,000 from NSF, $400,000 from Ellison, $200,000 from the Muscular Dystrophy Fund, $200,000 from the American Cancer Society, $4,200,000 from DOD, $1,266,394 from the Gates Foundation, $707,465 from the International AIDS Vaccine Initiative (IAVI) Neutralizing Antibody Consortium, $86,000 from the March of Dimes, $500,000 from the Murdock Charitable Trust, and $500,000 from miscellaneous grants and fellowships. In addition, the Howard Hughes Medical Institute (HHMI) generously supports two Investigators in our department (David Baker and Richard Palmiter) and until recently also supported three others (James Hurley, Wim Hol, and John Glomset who is on the verge of retirement). Needless to say, these funds (excluding those from HHMI) are not spread evenly across the faculty, especially in the current funding climate where even productive laboratories with a history of continuous NIH support have endured resubmissions or a temporary loss of funding. (In some cases, the department has provided modest bridge funding or, dollar for dollar, has matched awards of up to $50,000 from the UW Provost's Bridge Fund.) David Baker, whose powers of protein structure prediction and design have attracted the interest of many major foundations and companies, and who together with Research Assistant Professor Bill Schief directs a number of HIV Vaccine Design Projects, accounts for approximately $2,000,000 of the total direct costs most of which goes for salary support of computational biologists, and for the substantial (often hidden) infrastructure costs of massively parallel computation ("fat pipes" for data transfer, industrial-scale cooling lest the processors "fry", and uninterrupted power supplies to prevent crashes). Also, it is important to note from the departmental point of view that not all external funding agencies are as generous as NIH regarding indirect costs; the result is that total Research Cost Recovery (RCR) returned to the department is only $664,000 after the UW Provost and the Dean of the School of Medicine take their share.

A3. What are your unit's weaknesses? No unit is perfect. Where could yours most use improvement? What challenges or obstacles make it difficult for you to overcome these weaknesses? What further challenges do you foresee in the coming years?

Weaknesses. The Department of Biochemistry is not perfect, and our weakest link may be achieving full participation by both faculty and students in our many activities — whether these be departmental (seminar program, annual retreat, monthly Happy Hours, graduate student recruiting, departmental committees, etc.) or institutional (teaching of conjoint and minicourses, interdepartmental graduate program recruiting, School of Medicine committees, etc.). A disproportionate share of these responsibilities tends to fall on the younger and/or more generous faculty, although these inequities are decreasing as new faculty are hired, more senior faculty retire, and a more natural demographic balance is restored. The mirror image of this problem is the wild fluctuation from year to year in graduate student participation whether in graduate student recruiting, attendance at departmental seminars, weekly graduate student research presentations, and lunch with seminar speakers. Some years we have sparkplug students who keep student morale high; other years many activities seem to fall flat. The statistics of small numbers may play a significant role here; we matriculate between 3 and 6 new graduate students each year, who are sometimes gregarious, sometimes private. However, faculty and student attitudes may be connected, because participation (or lack of it) is contagious — especially so when students and postdocs are as acutely aware as faculty that funding is perilous, and every minute of research counts.

The Chair, the Graduate Program Advisor (Professor Jim Hurley) and Graduate Program Coordinator (Ms Kelley Pankow), have met with selected graduate students and postdocs to brainstorm about ways to encourage student participation, and this seems to be working. No seachange or complete overhaul may be required; the solution may be many small changes, as the following four vignettes illustrate: (1) Assistant Professor Tamir Gonen, chair of the seminar committee, has taken to walking the halls of J-wing and K-wing around 3:15 pm ringing a bell, dodging into each laboratory (including faculty offices), and reminding the preoccupied occupants that the department seminar begins at 4 pm. Unintentionally, and in the great tradition of experimental psychology, it would appear that our department is being trained to salivate at the sound of a bell for midafternoon tea, coffee, and cookies. (2) To lower the activation barrier for monthly (sometimes biweekly) Happy Hours traditionally organized by the graduate students, the department now stocks soft drinks, beer, wine, and munchies (all delivered by Costco) in the office tea room; the students no longer have to shop for each event, and hot pizzas are delivered directly to the lounge as Happy Hour begins. (3) To encourage graduate student participation in the Monday lunchtime student research presentations (no faculty allowed), the department "orders in" on a rotating schedule from Thai, Mexican, Indian, and French bistro takeout. The power of good food as a research tool cannot be overestimated. (4) The entire department brainstormed for an hour during our 2007 Annual Department Retreat at Sleeping Lady in the Cascades to reconsider the format, purpose, season, and place of our retreat. There was remarkable agreement among graduate students, postdocs, research faculty, and teaching faculty regarding the *pro*s and *con*s of the many possible options, and we continued this discussion at a formal faculty meeting soon after the retreat itself. The main conclusion was that both students and faculty were tired of hearing the same roster of faculty give very similar 10 minute talks every year; instead we will "mix it up" with talks by faculty, graduate students, and postdocs; both students and faculty will have posters in the evening session; and we will have occasional special sessions or guest lecturers on topics of general interest.

Our most serious challenges in the coming years are likely to be maintaining our research funding, and continually updating our teaching styles (see next section A4).

A4. What changes have occurred in teaching, research and service in your field over the past decade that have influenced your conception of the unit's role? What pressures, internal and external, have caused significant changes, and what further pressures and changes do you anticipate in the next ten years? What changes have taken place in the relationships between your field and other related fields?

Maintaining our funding. The primary challenge we are likely to face in the next decade is to maintain a level of external funding that will sustain our research momentum as a department and, most importantly, nurture our new faculty until their research programs are self sustaining (also see section A7). Of course excellent traditional research will bring in some funding even in times of scarcity; but these are also times of great change and grand challenges, and our research programs must evolve with the times (perhaps ahead of them) or cease to be competitive in the marketplace of ideas. Indeed, almost every research program in the department has diversified into biomedically relevant problems in health and disease; and many research programs have increased their reach and appeal by exploring the power of high technologies (ChIP and ChIP-chip, mass spec, metabolomics, genomics, cryo em, drug and vaccine design, distributed computing, high throughput screens, confocal and two-photon microscopy, mouse models, gene targeting, etc.). These directions have enabled us to approach new funding agencies including the Bill and Melinda Gates Foundation, the Washington State Life Sciences Discovery Fund, the Muscular Dystrophy Foundation, IBM, Medicines for Malaria, and targeted NIH programs such as the Northwest Genome Engineering Consortium.

Continuing to teach well. A secondary (albeit related) challenge will be to continue to fulfill all of our teaching responsibilities as our teaching faculty change through new hires and retirements, and as the fields themselves are redefined or blur together. Our department has by far the largest commitment to undergraduate teaching of any medical school department. We teach BIOC 440/441/442 for BS biochemistry majors, a three quarter introductory series with about 400 students, and 7 to 8 TAs each quarter; BIOC 405/406 for nonmajors of all kinds (forestry to fisheries, and possibly our own proposed BA majors), a two quarter series with 550 students, and 2 to 3 TAs each quarter; BIOC 426, a laboratory course given in both fall and spring quarters with over 50 students, and 4 TAs each quarter; and BIOL 200 with 300 freshmen/women. Thus over 15 regular biochemistry faculty (*not* lecturers or acting instructors) teach 2700 undergraduates every year. In addition, our department teaches HUBIO (Human Biology) 514/524, a two quarter introduction to biochemistry, molecular biology, and metabolism with 120 first year medical students each quarter. HuBio involves 4 regular faculty as well as 7 conference section leaders and two TAs. The HUBIO 514/524 course chair (currently Professor Nancy Maizels, primary in Immunology, joint in Biochemistry) also coordinates the Seattle courses and examinations with the equivalent biochemistry courses taught at the other WWAMI sites. (WWAMI is a five-state program in which **W**ashington, **W**yoming, **A**laska, **M**ontana, and **I**daho each teach the first year of medical school locally to encourage residents to practice in their home state after graduation; the students then migrate to Seattle for the 2nd, 3rd, and 4th years of medical school, nearly doubling the size of the Seattle class. This unique program spares the other four states the enormous cost and difficulty of maintaining a first rate medical school with basic science research programs, academic teaching hospitals, critical mass, etc.)

None of these courses stand still. A lecture to medical students in HUBIO 514 may incorporate material from the latest issue of *Nature* on use of gene expression profiling to distinguish potentially metastatic from noninvasive tumors; a lecture to undergraduate nonmajors in BIOC 405 may stress the role of ras-related small GTPases in striking a compromise between speed and accuracy in translation; and undergraduates in the BIOC 426 laboratory course may have the opportunity to genotype themselves. These are not isolated examples, and obviously the rest of the course material must be continually updated to accommodate these (and many other) intrusions from future history.

Shifting disciplinary boundaries. Most disciplinary boundaries are increasingly fuzzy and may ultimately become no more than a useful fiction to divide undergraduate course materials into teachable units. To give just a few examples, molecular biology, developmental biology, and structural biology often merge seamlessly in a single research program (D Kimelman, H Ruohola-Baker, S Hauschka); computational and structural biology are becoming one as each learns to inform the other (D Baker, W Schief, T Gonen); many of those who study yeast, perhaps the preeminent model organism, have diversified into related mammalian projects (T Davis, B Kennedy, A Merz); and the boundaries separating Biochemistry from Chemistry, Bioengineering, Nanotechnology, and Chemical Engineering are more blurred every day as the chemists, engineers, and nanotechnologists look to biology for inspiration. Indeed, a major philosphical (and occasionally political) debate within the bioengineering community is whether they are more like engineers or biologists! In addition, all the basic biomedical disciplines are becoming increasingly quantitative (consider mass spec, ChIP, or gene or trait mapping), so Professor John Aitchison (Institute for Systems Biology, Affiliate Professor of Biochemistry) has instituted a new course (CONJ 526) entitled "Introduction to Systems Biology and Quantitative Approaches to Biomedical Sciences" to help students understand what systems biology is, how it influences experimental design, and how new quantitative tools are reshaping genomics, proteomics, modeling of all kinds, and data integration.

Wither metabolism? Perhaps the greatest single challenge will be to maintain our teaching of the traditional shibboleth, bugbear, and core of biochemistry: intermediary metabolism. Fortunately, this is a field in renaissance; it is no longer just gout and phenylketonuria. Consider the ability of Sir2 homologs to connect chromatin structure with metabolism in health and aging; or metabolomics — the ability of mass spec to correlate changes in low molecular weight metabolites with physiological conditions or disease; or the ability of bioinformatics to deduce novel metabolic pathways from DNA sequence alone in organisms from archaeal thermophiles to humans; or the emerging realization that regulation of gene expression, and signal transduction pathways, ultimately regulate metabolism in ways that can only be understood by a systems biology approach. Even *Cell*, perhaps the trendiest of all high impact journals, has spawned *Cell Metabolism*. Although faculty trained in the traditional arts of metabolism are increasingly scarce, the discipline is in no danger of a premature demise because it is as central today as it was when biochemistry was little more *than* metabolism; however, metabolism will be taught in new ways by new people and for new reasons. NADH may no longer be just a handy electron carrier, but a bellweather of metabolic state; and a deeper understanding of "metabolic syndrome" may require systems biology to integrate molecular information on cell signaling, differentiation, glucose metabolism, hemostasis, and inflammation.

Undergraduate advising on a grand scale. The Biochemistry major began small as an honors specialty within the Chemistry major, and then grew steadily as the nascent fields of molecular biology, molecular genetics, and structural biology developed ever more powerful techniques for studying biological macromolecules and their interactions. No one could have imagined, when the Department of Biochemistry in the School of Medicine assumed responsibility for undergraduate biochemistry course, that by 2007 there would be more Biochemistry than Chemistry majors, or that the numbers would be so daunting (772 Biochemistry majors and 605 Chemistry majors, for a grand total of 1377). As a result, our department has far heavier teaching responsibilities than other basic science departments in the School of Medicine; however, biochemistry majors typically do not take a formal course in biochemistry until junior year because biochemistry must build on a firm foundation of chemistry, biology, genetics, physics, and mathematics. That is why the Biochemistry major is administered out of the Department of Chemistry where Ms Lani Stone and Ms Mary Harty capably advise both Chemistry and Biochemistry majors. The Biochemistry major was far smaller when this arrangement of convenience began, but Lani and Mary continue to do a superb job, and our department is delighted to help support them; the two of them give every one of our students individual attention, and we would not dream of changing this arrangement in any way (see http://depts.washington.edu/biowww/undergradprogram/index.html).

New teaching tools for a new century. We are currently teaching lecture classes for 400 students each quarter (the introductory BIOC 440/441/442 series for majors) and 550 students each quarter (the introductory BIOC 405/406 series for nonmajors). We are able to do this, instead of wastefully teaching the same course twice in two shifts, because UW has invested in superb physical and technical resources. Several newly renovated auditoriums in Kane on Upper Campus manage, through good design and human engineering, to achieve a compromise between immensity and intensity. UW has also been at the forefront in use of web-based learning tools. The "Catalyst" group (http://catalyst.washington.edu/) provides attractive, easy-to-use tools for "Learning and Scholarly Technologies": Among these tools are "SimpleSite," providing menu-driven course website design for faculty who are not literate in HTML; "GoPost," a chatroom where students and faculty together can discuss and answer questions about course and quiz materials (see below); and PodCasting where students can review a lecture they attended, or hear and see a lecture they missed (complete with high resolution PDFs of the slides). About half the students typically attend any given lecture, with the rest watching the podcast, so all students benefit both from the motivation born of immediacy, and the convenience of "distance learning."

GoPost. In BIOC 405/406, our introductory biochemistry series for nonmajors (and proposed BA majors) with an enrollment of 550, GoPost chatrooms have allowed the better students to become informal teaching assistants for their peers. Faculty chime in on GoPost only when the questions or answers appear to be going south, and mischief is nonexistent because all contributions to the chatroom are securely signed, dated, and undeletable. Thus GoPost chatrooms become a form of virtual small group learning, and help to break down an immense lecture into more intimate self help groups. In fact, GoPost allows classes to be formally divided into sections, so 10 groups of 50 students can converse, instead of a crowd of 500. We are lucky that UW is staying ahead of the technological curve; it will enable the university to fulfill its charge of educating the youth of the state, but without costly increases in the size of the faculty.

Audience (or Student) Response Systems. The UW Teaching Academy offers many Faculty Workshops on Teaching and Learning, all designed in response to faculty requests, and featuring specific skills, knowledge, and technology that should be useful in UW classrooms. The January 25, 2008 workshop on "Audience Response Systems: Using Technology to Bring Added Value to Classroom Instruction" was especially appropriate for very large classes such as our introductory undergraduate biochemistry course for BS majors (BIOC 440). Although blessed with 6 or 7 TAs who lead "quiz sections", BIOC 440 has experimented successfully with "clickers" — the casual name for an Audience (or Student) Response System (SRS or ARS). A half dozen students seated near each other in the lecture hall form a group, spend a few minutes discussing a problem posed by the lecturer, and click on an answer. A device on the podium tallies the clicks, and the lecturer then announces how many groups got it right, and why.

Problem-based learning (PBL). Another alternative to sponge-like note-taking behavior occurs in our introductory biochemistry course for first year medical students (HUBIO 514) with an enrollment of 110, where the faculty member in charge (Nancy Maizels) has recruited graduate students, postdoctoral fellows, and senior fellows to lead 7 "conference sections" of about 15 students each who discuss prepared materials in a problem-based learning (PBL) environment that connects lecture with clinical practice (see section B8 for more on PBL).

A5. Do you observe differences between your view of your role and college and university expectations of your unit? If so, what are these? Do you see any ways to resolve these differences?

Our undergraduate major as a collaborative effort. Not unlike many other departments of biochemistry that are physically located within a medical school but have dual roles in undergraduate and medical education, our department sometimes feels underappreciated: The School of Medicine does not always seem to understand the magnitude of our commitment to undergraduate education, while the research prowess and heavy teaching responsibilities of the Departments of Biology and

Chemistry tend to obscure the contributions of our Biochemistry major to the College of Arts and Sciences although many other undergraduate majors (Fisheries, Forestry, Oceanography, Microbiology, Bioengineering, etc.) benefit from good introductory biochemistry taught at both the major (BIOC 440/441/442) and nonmajor (BIOC 405/406) levels. An additional problem is that our Biochemistry major (like those elsewhere) necessarily stands on the shoulders of giants: Students must take biology, introductory and organic chemistry, math, and physics *before* their first formal biochemistry course in junior (or even senior) year. Our departmental predicament may therefore simply come with the territory: schools of medicine, undergraduate colleges, and university science departments have very different missions, needs, funding sources, responsibilities, and organizational structures; thus our smoothly functioning and ever growing undergraduate biochemistry major should properly be seen as something that many UW departments and schools, collectively, can be proud of.

A6. Describe faculty participation in the process of unit governance, self-study, and strategic planning. How does your faculty participate in governance and strategic planning?

Authorship. This self-study was written by the chair, with some fact gathering by our Graduate Program Coordinator, Kelley Pankow, and our Administrator, Paul Pearson. I could not imagine having every faculty member, or even selected faculty, critique and suggest changes to this document because the faculty do not think with one mind or speak with one voice. Thus the simplest strategy seemed to be a single author who would be familiar with most points of view, and solely responsible for any misrepresentations, errors, or omissions that remain.

Faculty meetings. The chair has avoided regular monthly faculty meetings except when there were issues that needed group discussion, or decisions where an e-vote could not substitute for face-to-face discussion. A few faculty seem to feel that regular faculty meetings are essential for shared governance, even when there is little of consequence to discuss; but most faculty seem to agree with the chair that uninteresting faculty meetings are not a good use of precious time, and make it more difficult to muster good attendance when we really need it. Nonetheless, we faculty see each other regularly because most of us have contiguous research space on the 3rd, 4th, 5th, or 6th floors of J-wing or the 5th floor of K-wing; we are in and out of our departmental office in J-405 several times a day; and we attend Thursday afternoon departmental seminars, Friday Faculty Lunch Talks, and monthly (or occasionally biweekly) Friday afternoon Happy Hours.

Strategic planning. The department has not formally or directly addressed "strategic planning," but we do so indirectly whenever we discuss which job candidates we should invite to Seattle, and how we feel about them after the interviews. All five of our job searches since 2001 have been untargeted for two main reasons: First, a targeted search forces many difficult questions — should we strengthen existing areas, strike out into new ones, try to maintain balance among perceived affinity groups within the department, or even look for interdisciplinary candidates who will strengthen science in other departments here in the School of Medicine as well as our own? Attempts to resolve these questions can polarize faculty across disciplinary boundaries whereas real candidates in an untargeted search tend to blur or transcend the very same (often illusory) boundaries. More crudely put, hypothetical candidates tend to divide us; real candidates to unite. Second, there is no guarantee that the small number of potential candidates who meet the criteria of a targeted search will excite or appeal to the faculty as whole. Yet it is always better to refrain from hiring in a specific area than to hire the wrong person, regardless of how demoralizing it is when a search comes up empty handed. The chair was a member of each search committee, but spoke out only after the interviews when the faculty debated a formal rank list: A number of candidates favorably impressed many faculty, but struck the chair as weaker than advertised, or potentially divisive, or too limited in scope to help bring the department together. However, the chair did not argue against, and indeed zealously pursued, several candidates who seemed unlikely — based either on personal style or a known "two body problem" — to join our department no matter how warm a welcome we extended, or how good an offer we made (see Appendix J).

Gender balance and underrepresented minorities. The Program Review Committee will not fail to notice that the three new faculty hired since the current chair arrived in 2000 are all male. The chair and all members of the department are acutely aware of this disconnect, and have struggled to do better. Note however that offers have been made over the past 6 years to 5 women, 1 African-American male, and 1 Japanese male (Appendix J), and that the chair went the distance to make them feel welcome in the department on both the first visit when they came alone, and on the second visit when accompanied by spouse, significant other, and/or family. We are currently in the middle of our 6th untargeted junior faculty search. After reading over 300 applications, the search committee invited a short list of 7 candidates including 4 women and 3 men, of whom 5 are foreign born (3 Chinese, 1 Russian, and 1 Romanian).

A7. Is mentoring junior faculty identified as a priority? Outline your unit's approach to mentoring junior faculty, graduate students, undergraduate students.

Junior faculty mentoring. Mentoring our junior faculty is one of our highest priorities. The chair believes that when we hire new faculty, we effectively sign a contract guaranteeing them the best possible environment in which to flourish as researchers, scholars, teachers, and colleagues. To provide any less than this would be a breach of contract. Also, for each of the three junior faculty positions we have filled since 2001, we conducted an untargeted search within the broad area of biochemistry and received over 400 applications. Thus there is every reason to believe that the new faculty we have hired are the strongest candidates who represent the best possible fit between our needs and theirs. Indeed, as I tell all candidates during the interview process, we know that whoever we hire will have all it takes to succeed; and the job of our department is not to judge them after they arrive, or to put more obstacles in their path, but to help them find their way in the brutally competitive outside world of funding, publication, and recognition.

The chair made a serious effort, on more than one occasion, to persuade each of our new hires to suggest an appropriate mentoring committee, but each of them is so gregarious, so eager for advice, and so comfortable with a diversity of wise opinion that the entire department was, in effect, enlisted as the mentoring committee; thus there seemed no point in formally designating any subset of our faculty to take credit (or blame!) for a role happily played by the group at large.

Section B: Teaching

B1. For each faculty member in your department, please list: number of courses taught per year, number of credits taught, and total student credit hours.

Faculty teaching loads. See Appendix K. Two explanatory notes:

(1) This tabulation does not include BIOC 499 ("Undergraduate Research") which is tabulated separately in Appendix L; or BIOC 520 ("Seminar"), the formal course designation for our Thursday departmental seminar series which first year graduate students are required to attend; or the many BIOC 500 levels courses — for example, BIOC 529 ("Molecular Biology of Early Development") offered by Professor Kimelman during all four academic quarters — which are in reality individual research group meetings. These research group "courses" came into existence years ago to address a misperception at the state level that faculty teaching loads were limited to formal classroom instruction.

(2) Credit hours usually correspond to formal student "contact hours" — thus 3 credits for BIOC 405 and 406 which meet 3 times a week; 4 credits for BIOC 440. 441, and 442 which also have 1 hour "quiz sections"; and 4 credits for BIOC 426 because laboratories inevitably run late. *Note however that "contact hours" are only a rough measure of student effort, and hardly measure faculty effort at all.* In fact, the effort required for faculty to prepare lectures and materials for 300 students (Biology 200), 400 students (BIOC 440/441/442), or 550 students (BIOC 405/406) increases with increasing class size because there is little margin for error when so many students and TAs are involved. In these huge classes, the effect of any delay, misunderstanding, factual error, or organizational problem has to be seen to be believed.

B2. How are teaching responsibilities allocated? For interdisciplinary programs: How are teaching loads negotiated and balanced between home departments and the interdisciplinary unit?

Faculty teaching assignments. Assignments are made by the chair in consultation with the faculty involved or affected. Newly hired junior faculty ramp up to full teaching responsibilities over 2 to 3 years, albeit at somewhat different rates depending on department needs and their other responsibilities. All other FTE faculty are expected to teach at least 5 weeks of a 10 week quarter in a sizeable lecture course like the 2 quarter introductory BIOC 405/406 series for undergraduate nonmajors (550 students), the 3 quarter BIOC 440/441/442 series for undergraduate majors (400 students), or the 2 quarter HuBio 514/524 for first year medical students (120 students). For historical reasons that the current chair could not easily reverse, a few of our FTE faculty have taught very little; and some of our research faculty have chosen, for personal or professional reasons, to teach every year and are appropriately compensated for their efforts. A few FTE faculty also volunteer to teach 5 week departmental "minicourses" (seminars) in their area of research interest, or 10 week interdisciplinary "conjoint" courses (usually seminars but occasionally lecture/seminar combinations) in the core curriculum of the Molecular and Cellular Biology Graduate Program; these minicourses and conjoint courses combine self promotion with selfless service, and do not reduce or satisfy the responsibility to teach 5 out of the 10 weeks in a major departmental lecture course. "Conjoint" courses involving faculty from more than one department or discipline (section A1b) have not required negotiation between faculty or departments, because self promotion is a sufficient reward in the quest for new graduate students.

TA assignments. Faculty teaching assignments are only half the challenge; we also care deeply that our teaching assistants (TAs) are assigned to courses where both they and the undergraduates will benefit, and we can mentor the TAs most effectively. Given the size of our undergraduate courses, this is no small task. We typically assign 6 or 7 TAs to each quarter of the introductory biochemistry for majors (BIOC 440/441/442), 2

TAs to the introductory biochemistry for nonmajors (BIOC 405/406), and 4 TAs for each quarter of the introductory biochemistry laboratory (BIOC 426). Our own biochemistry graduate students could not possibly meet these needs, so we rely on students from three other graduate programs who are required, like our own students, to teach for two quarters as part of their graduate education. These three programs are the Molecular and Cellular Biology (MCB) Program, the Biomolecular Structure and Design (BMSD) Program, and the Medical Scientist Training Program (MSTP) aka the MD/PhD Program. We circulate descriptions of our courses to these other programs, asking the students if they are interested in TAing particular biochemistry courses (see Appendix M for TA assignments by graduate program in 2007-2008). We almost always get enough volunteers because our courses are well organized, and our faculty have a reputation for respecting and mentoring TAs despite (or perhaps because of) the huge size of the classes (typically 550 in the BIOC 405 series, 400 in the BIOC 440 series).

With so many TA assignments to be made, our department tradition — which preceded my arrival as chair — was for a biochemistry graduate student to assist the Graduate Program Advisor and/or Graduate Program Coordinator in making TA assignments. This was not merely a matter of transparency in self governance, but a practical and strategic decision: Graduate students always know each other better than the faculty know them, and a well informed student can be incredibly helpful by serving as an intermediary between faculty and students, balancing student interests, talents, and schedules against departmental needs. Since my arrival, I have done the TA assignments with the help from a graduate student who usually volunteers, or is chosen by acclaim, or is occasionally elected by fellow students. The student usually serves for several years, until another equally talented student emerges, or the demands of thesis writing begin to outweigh the genuine satisfactions of making assignments that improve the welfare of all.

B3. Other than classroom teaching, how are faculty involved in undergraduate student learning and development (for example, advising, mentoring, and supervising independent study)?

Undergraduate advising by faculty. As mentioned above (section A4), we support and work closely with our two undergraduate Biochemistry advisors, Ms Lani Stone and Ms Mary Harty, who do most of our formal advising about course requirements, scheduling, credits, etc. We would be lost without them, because the number of Biochemistry majors (currently 772) and Chemistry majors (currently 605) continues to grow; the Chemistry and Biochemistry majors share the first two years and diverge only slightly in the fourth; and there is no way that our small faculty (or even the much larger Chemistry faculty) could effectively advise 1377 students each of whom, it would seem, has unique issues and dilemmas.

Ms Stone and Ms Harty encourage students with more serious scientific questions to take them directly to our faculty. To my knowledge, all of our teaching faculty are informal and approachable; none of them pontificate or stand on principle, and I am confident that any undergraduate with a weighty question would not hesitate to ask our faculty either after class, by email, or by appointment. In fact, I am often surprised by how frequently undergraduates email *me* simply because I am chair. I never would have dared to email the chair of my major department (Chemistry) even if email had existed in those ancient times.

B4. How do faculty involve undergraduate students in research and scholarship?

Undergraduate research. As tabulated in Appendix L, many of our faculty have undergraduates in their research groups, some for course credit during the academic year (BIOC 499), some as summer employees, and some supported during the year by prestigious undergraduate fellowships such as the Levinson Emerging Scholars Program which currently supports Jonathan Keller, a senior in Biochemistry (www.washington.edu/research/urp/students/studentprofiles.htm). UW undergraduates often email all of our faculty hoping for an interview; others get to know specific faculty through one of our large undergraduate courses. Undergraduates are not employed as low level technicians but as potentially equal members of the research team; the more involved they become in their project, the greater their autonomy, and many choose to work in the same research group for both junior and senior years. Indeed, mentoring an undergraduate is usually lots of fun: Undergraduates typically make up in enthusiasm what they lack in experience, and it is quite a privilege to introduce an undergraduate to the friendly art of research because the reality (no white coats, faculty and students on a first name basis, constant chatter and exchange of ideas) is so different from the common misconceptions (austere, formal, solitary or silent).

Undergraduate research projects do not stop in our department: The University as a whole does a marvellous job of honoring undergraduate contributions to our life as a research university. The Eleventh Annual Undergraduate Research Symposium will be held Friday, May 16, 2008 in Mary Gates Hall. Ed Taylor, Vice Provost and Dean for Undergraduate Academic Affairs, writes in his email announcement that the symposium "offers an exciting public forum for students to present their work and showcases undergraduate research from academic departments across the UW's colleges, schools, and campuses. Participating students may also nominate their faculty mentors for an undergraduate research mentor award.... Last year, over 620 undergraduates presented at this event and we expect this year's celebration of undergraduate scholarship and faculty mentoring to be bigger than ever." We are proud that a state university with almost 28,000 undergraduates can still care about every one of them!

B5. How does the department evaluate the instructional effectiveness of faculty?
B6. Please summarize the data you collect, possibly using OEA or CIDR, to evaluate the impact of your teaching on student learning. Please describe selected specific changes you have made in response to the data you have collected.

Teaching evaluations. We participate in the student evaluations prepared by the Instructional Assessment System (IAS) administered by the UW Office of Educational Assessment (for undergraduate courses) and the HuBio Online Course Rating System administered by the Department of Medical Education and Biomedical Informatics (for School of Medicine courses); however, these are only a starting point for evaluating instructional effectiveness (see section A2 above for details). The HuBio Online Course

Rating System reports are quite useful because, in addition to two simple overall scores ("Amount learned from Dr. X's presentations" and "Overall teaching effectiveness of Dr. X"), the questionnaire provides room for freeform comments, which are then carefully compiled verbatim under broad headings (for example, "Strong points of Dr. X's presentations" and "Suggestions for improvement by Dr. X"). In constrast, the IAS questionnaire is a multiple choice test with 31 questions, and there is no provision for comments that break the mold (Appendix I). Although some of the questions sound innocent enough ("Student's confidence in instructor's knowledge" or "Instructor's interest in whether students learned") the paradoxical result is that faculty who come across as friendly or solicitous of student approval are often mistaken for uncertain or uninformed, while faculty who adopt an authoritative tone are assumed to be knowledgeable and in control. On the other hand, some IAS questions are useful and unambiguous ("Instructor's ability to present alternative explanation when needed", "Clarity of student responsibilities and requirements", and "Instructor's enthusiasm"). No doubt all surveys are flawed, but anecdotal freeform comments provide a better pathway to improvement than finding out that the students have no confidence in your knowledge of your own field!

Most faculty are understandably reluctant to evaluate or critique each other's teaching. The more public aspects of "best teaching practices" are easy to discuss (how to administer an exam, how to mount materials on the course website, how to prepare and mentor TAs, etc.) but the more personal aspects of teaching (speaking style, pace, fielding questions, etc.) are far more difficult to address, probably because one size never fits all. Indeed, a good argument can be made that a diversity of teaching styles and approaches should be celebrated not critiqued; we have all liked some teachers better than others, but it is not always the *same* teachers. This is one of many reasons why the chair has not asked faculty to evaluate each other; senior faculty are not necessarily in a good position to critique younger colleagues, or even to agree among themselves about how best to teach. Instead, our collective commitment to teaching is so strong that the chair trusts faculty to coach and mentor each other within the limits of collegiality. The chair, however, has not been hesitant to attend lectures, to make frank comments about everything from content to speaking style, and in rare cases to change teaching assignments.

B7. What procedures, such as mentoring junior faculty, does the department use to help faculty improve undergraduate teaching and learning? What training and support is provided to TAs to help them be effective in their instructional role?

Instructional development opportunities. The UW Center for Instructional Development and Research (CIDR, pronounced "cider") sponsors many workshops for TAs (http://depts.washington.edu/cidrweb/events/), most importantly the annual TA Conference on Teaching and Learning which is always scheduled just before the beginning of the fall quarter. This conference is required of *all* our incoming graduate students, and is designed to prepare them for their roles and responsibilities as TAs. The TA Conference offers more than 150 workshop sessions, led by experienced UW TAs and faculty, for more than 700 graduate students.

Sponsored by the Office of the Provost, the UW Teaching Academy collaborates with CIDR, the Office of Minority Affairs and Diversity, UW Catalyst (section A4), and the Office of Educational Assessment (sections A2 and B5,6) to offer many Workshops on Teaching and Learning for faculty and advanced graduate students who have served as instructors. These workshops are created and facilitated by UW faculty who have received campus-wide recognition for their effectiveness in teaching, and designed with the needs of both seasoned professionals and newcomers in mind.

B8. How does the unit track and promote innovations and best practices in undergraduate and graduate student learning?

The future history of teaching. The chair notifies faculty regarding workshops of the UW Teaching Academy (http://www.washington.edu/uaa/teachingacademy/programs-workshops.html) but most of our faculty have been teaching for many years, and the Teaching Academy's Annual Institute for Teaching Excellence requires a full week commitment. The chair also passes along announcements of shorter events such as the Third Annual Teaching and Learning Symposium (April 24, 2006, 2:30-4:30 pm).

Following his participation in "2040 Vision: *the impact of UW research in the decades ahead.* A forum in honor of Lee Huntsman's 36 years at the University of Washington" (Playhouse Theatre, June 4, 2004), the chair made a serious effort to provoke faculty interest and participation in innovative teaching techniques. Two publications were distributed and discussed at a faculty meeting. Handelsman et al. (2004) Scientific Teaching. Science 304, 521-522 addressed two major problems: Small group learning strategies to reenergize large lecture courses, and highly interactive problem-based learning (PBL) approaches to replace the passive unidirectional transmission of knowledge (student as sponge). We also discussed Bialek and Botstein (2004) Introductory Science and Mathematics Education for 21st-Century Biologists. Science 303, 788-790 who explored two big challenges: Can we break down the traditional disciplinary boundaries between mathematics, computer science, physics, chemistry, biology, and medicine so as to prepare undergraduates for an interdisciplinary future? And, since knowledge is constantly expanding but students cannot learn everything before beginning productive scientific lives, What is the least a student can know and still go on to do creative biological and biomedical research? There was some interest, but apparently not much response at the time, perhaps because there were no facilities or funds or staff for small group discussions in a class of 400 or 550 students. Yet only 3 years later, to my surprise and delight, our faculty have begun to use two UW learning tools — GoPost and Audience Response Systems — to create a small group atmosphere and problem-based learning environment in even the largest of our undergraduate lecture courses (see section A4 above for a detailed description). This means there is hope for large state universities without large private budgets.

Section C: Research and Productivity

C1. How does your unit balance the pursuit of areas of scholarly interest by individual faculty with the goals and expectations of the department, school, college and University? How are *decisions involving faculty promotion, salary and retention made? For interdisciplinary programs: How do you balance the demands of home departments and of the interdisciplinary unit?*

Balancing goals and expectations. We are fortunate that our multiple roles as teacher, scholars, and experimentalists fit together seamlessly and indeed reinforce each other. Whether we are teaching the Central Dogma to first year undergraduates in Biology 200, vertebrate embryogenesis to majors in Biochemistry 442, the principles of NMR to graduate students in Biochemistry 530, or reactivation of telomerase in human tumors to first year medical students in Human Biology 514, we are teaching what we enjoy to others who we hope will enjoy it too. Our teaching includes all schools, and all levels, and all are equally valued within the department; the teaching load is similar to that for most departments of biochemistry elsewhere, typically a little less than other basic science departments here in the College of Arts and Sciences, and a little more than in other departments in the School of Medicine.

Promotion criteria. Our department criteria for promotion (Appendix N) require a combination of creative and productive research, national and/or international prominence, good teaching, and service at the department, university, and national level. We look for an upward career trajectory for promotion from assistant to associate professor, and a sustained trajectory for promotion from associate to full professor. According to the Faculty Code, an Assistant Professor at the University of Washington is appointed for a period of 3 years, reviewed midway through the second year for reappointment to a second 3 year term, and considered for promotion to Associate Professor before the 6th year; promotion to full Professor can occur any time thereafter. Nearly all our teaching faculty have tenure-track appointments corresponding to a state-funded faculty line ("FTE" or full time equivalent), and tenure is awarded upon promotion to the rank of associate professor. Research faculty are not required to teach, and are supported entirely by external funding. Only a few of our teaching faculty are not supported by an FTE and they hold rank "WOT" meaning "without tenure by reason of funding"; these faculty are supported largely by external funding, but compensated by the department for their teaching responsibilities.

Salary determination and equity. According to the Faculty Code, salaries can be determined either by the decision of those senior in rank, or by written agreement that all salary decisions are made by the chair in consultation, where necessary, with others. The current chair is pleased that the latter tradition prevailed in the department before his arrival, and continues today. Salary decisions are ultimately made by the chair, but always in consultation with the Biochemistry Administrator, and always based on considerations of seniority, equity, scientific excellence, service, funding, and retention. There have been no complaints at all regarding salaries since the current chair arrived, nor any criticism or correction by the Gender Salary Equity Committee of the School of Medicine Dean's Office currently composed of Chris Surawicz (Committee Chair), Stacy Fauchald (Manager, Faculty Compensation, Administration and Finance), and Barbara Van Ess (Director of Personnel Policy and Faculty Administration). The committee meets face-to-face with the Chair and Administrator of each department every other year to review all faculty salaries with respect to gender, degree, rank, and years in rank in order to assure equity.

Merit and retention. Salaries of faculty supported by an FTE consist of A and B components where A is the state-funded FTE component and B is funded by external research grants. The B component averages 22% over all tenured and tenure-track faculty in our department (Appendix B), but varies from 0 to 25% of total salary depending on the FTE available at time of hire, the cumulative effect of salary decisions made by the faculty member, and the current level of external research funding (see below). The university decides every year on the maximum *average* increase in FTEs within any department or "unit" based on the current state budget and other considerations. This increase usually consists of a "merit" component (typically 2 to 4%) and less frequently a "retention" component to make up for the inevitable slippage in overall salary levels. The current chair assumes that all our faculty are equally meritorious of a state-funded increase because (1) the merit component is too small to justify making the emotionally charged distinction between more and less meritorious; and (2) extraordinary merit can almost always be compensated by external funding sources as explained next. Once the state-funded merit and retention increases are known, the chair emails the FTE faculty assuring them that they are all equally meritorious and that the department is equally committed to retaining all of them; at the same time, faculty are invited to suggest increases (up to 6 or 8%) in the B component of their salaries to be funded by their external awards. Only those with sufficient external funding (and thus extraordinary merit) can choose to award themselves this additional increase in the B component. Thus all faculty are considered equally meritorious within the university, but external funding is used as a measure of merit outside the university. Salaries that are funded entirely (research faculty) or almost entirely (faculty WOT) by external research grants are allowed to increase at the same rate as teaching faculty salaries supported by the A+B system. For these salaries, which are in effect all B component, external funding also functions as a measure of merit. Chairs advise the Dean of the School of Medicine, but do not participate in the negotiations between the Dean and HHMI that determine HHMI Investigator salaries.

C2. How are junior faculty members mentored in terms of research and creative productivity?

As described above (section A7), our junior faculty have adopted the entire department as a mentoring committee. As no mentoring committee is likely to come up with unanimous recommendations or a failsafe recipe for success, I actually consider community mentorship superior to an appointed committee, or even a committee hand chosen by the junior faculty member her/himself; the junior faculty member is then free to take or leave any particular nugget of advice, without the moral onus of appearing to reject the advice of one or more members of a senior faculty committee. I would however insist on appointing a committee if I sensed a more serious problem with any of our junior faculty at any time.

C3. What has been the impact of your research on your field and more broadly over the past five years? 4. In what ways have advances in your discipline, changing paradigms, changing *funding patterns, new technologies, or other changes influenced research, scholarship, or creative activity in your unit?*

Impact of our research. We are both fortunate and unfortunate that external funding serves as a crude measure of individual and collective success: fortunate because the criteria of success are clear, encouraging us to formulate and strive toward well defined goals; but unfortunate because snazzy science is more easily funded than methodical science, especially in hard times, although each style of research has a role to play in the overall advance of biomedical sciences. Admittedly, no funding climate is perfect: ample funding can encourage self indulgence, a narrow focus, and intellectual stasis; scarce funding encourages large leaps, but has a high casualty rate, and often selects for those who promise more than they are likely to deliver. Our overall department funding has held fairly constant since the doubling of the NIH budget ended in 2003; this is quite an accomplishment, but it conceals a significant redistribution of dollars, and a great deal of uncertainty, misery, and wasted months trolling for funds instead of doing research. A chair would never say that scarce funding is a good thing, but it is not an entirely bad thing either; harsh winters can prune weak branches, and encourage new growth from heallthy stock.

Impact can be measured by the "Impact Factor" as popularized and computed by the Institute for Scientific Information (ISI), or by the newer, more useful, but less widely known "h-factor" [JE Hirsch (2005) An index to quantify an individual's scientific research output. PNAS 102, 16569-16572]. All such factors, however, can be misleading because heavily cited authors are often subject to "accretion", meaning that it is easier to attribute major progress to a single research group, than to carefully track the many groups where credit is due. I would therefore prefer to go the old fashioned route, mentioning some of our conspicuous successes without adducing numbers to support the importance of the achievements: David Baker has led the pack in protein structure prediction, earning the 2004 Feynman Prize in Nanotechnology and election to the National Academy of Sciences (depts.washington.edu/biowww/news/index.html); Hannele Ruohola-Baker has demonstrated involvement of miRNAs in embryonic stem cell division (depts.washington.edu/biowww/news/microRNA.html); Steve Hauschka, along with his former student Jeff Chamberlain (now a professor in Neurology), has played a major role in bringing gene therapy for muscular dystrophy closer to reality (depts.washington.edu/chamblab/); Richard Palmiter has generated and studied dopamine-deficient mice that may shed new light on causes and cures for Parkinson's disease and drug addiction (www.hhmi.org/research/investigators/palmiter.html); Rachel Klevit has used NMR to determine structures that begin to explain why certain BRCA1 mutations predispose to breast cancer (depts.washington.edu/biowww/news/arch-cancer.html); Brian Kennedy and Matt Kaeberlein (Pathology) uncovered a signalling pathway (depts.washington.edu/biowww/news/longevity.html) that links nutrition and aging; and Nancy Maizels, Barry Stoddard, Ray Monnat, and David Baker are redesigning a homing endonuclease for use in site-specific gene targeting [Ashworth et al. (2006) Nature 441, 656-659].

C5. Some units are more heterogeneous than others. What variations exist among your faculty in terms of methodologies, paradigms, or subfield specializations? Are faculty offices all in the same building, or are they geographically dispersed? What strengths and weaknesses for the unit as a whole are generated by differences among its faculty? Do any of these differences generate obstacles to communication? If so, what strategies has the unit developed to promote communication between different constituencies, and how successful have these strategies been?

Intellectual diversity. As mentioned above (section A1a), biochemistry departments as diverse as ours often divide into at least 4 affinity groups or camps (biochemists, and structural, molecular, and developmental biologists). We do not have this problem, probably because the highly collaborative UW research culture fosters so many collaborations that the value of diversity, both within and outside the department, is self evident to all. David Kimelman collaborates extensively with Wenqing Xu in BIological Structure; Trisha Davis collaborates with Chip (Charles) Asbury of Physiology and Biophysics; Wim Hol collaborates with Ken Stuart of SBRI (Seattle Biomedical Research Institute); Rachel Klevit collaborates with Mary-Claire King of Genome Sciences and Bill Catterall of Pharmacology; Brian Kennedy collaborates with Matt

Kaeberlein and Peter Rabinovitch of Pathology; Nancy Maizels collaborates with Barry Stoddard of the Fred Hutchinson Cancer Research Center and Ray Monnat of Pathology; and David Baker collaborates groups too numerous to mention both within and outside the department (including the chair's group).

Physical proximity. As mentioned in section A6, proximity is good for science and for collegiality. Thus we are lucky that all primary appointees in our department are located either in J-wing, completed in 1965 under the watchful eyes of Herschel Roman (Chair of Genetics) and Hans Neurath (founding Chair of Biochemistry) (www.gs.washington.edu/news/history/50years.html) or in the contiguous K-wing completed in 1995 (depts.washington.edu/biowww/whoarewe/index.html). We are also lucky that the Health Sciences Complex, although superficially monolithic, is actually composed of contiguous buildings (or "wings") connected by a single large corridor running east/west, with stairwells at either end of each individual "wing" (Appendix O). As a result, it is easy to carry an ice bucket from the 4th floor of H-wing to the 2nd floor of J-wing (thus collaborations) or to attend seminars, faculty meetings, thesis talks, etc. without ever remembering an umbrella or donning a coat (thus good interdepartmental relations and collaboations). The ease of travel between wings, departments, and laboratories actually makes the Health Sciences Building feel *smaller* than other medical schools where individual buildings are separated by skybridges or street level crossings.

C6. What impediments to faculty productivity exist, and do you see ways of reducing these?

The doubling of the NIH budget was not an unalloyed good for biomedical research, because no provision was made for surviving on the plateau when doubling ended in 2003. The plateau is admittedly high, but many of those who came of age as graduate students and postdocs when the crunch began have witnessed the constant struggle for funding and concluded that other career paths are worthy of consideration. This is not entirely bad, as a background in experimental science can be put to many excellent uses; on the other hand, to train and lose so much talent is wasteful and ultimately counterproductive. These are not problems that can be solved at the department or university level.

C7. What steps has your unit taken to encourage and preserve productivity on the part of all segments of your staff? How are staff recognized and rewarded? What programs are in place to support professional development of staff?

Office management. Our department Administrator, Mr Paul Pearson, also manages our departmental office and staff, and is universally liked and treasured; his warmth, competence, indestructible good humor, personal wisdom, relentless work ethic, and comprehensive knowledge of all the mysterious bureaucracies we must deal with (UW, SOM, NIH, INS, etc.) make our lives infinitely more pleasant. The faculty and staff have nominated Paul four times for the UW Distinguished Staff Award, and we will not give up until he wins. Our department office functions superbly because Paul creates and maintains a workplace atmosphere where everyone is valued, and pride can be shared by all in a job well done. As chair, I am in and out of the department office suite countless times each day, and I work hard to reinforce the healthy work environment by showing respect, never pulling rank, and forgiving others for errors and omissions more often than I forgive myself.

Staff enrichment. UW provides many opportunities for our staff to increase their skillsets and prepare for more advanced, responsible, or highly paid positions. Our webmistress Ms Teri Alvarado took courses in web design, HTML, Excel, and PhotoShop; our payroll manager Ms Ekua Wulff-Tagoe took courses in the intricacies of INS procedures, communication, and time management; and our Graduate Program Assistant, Ms Kelley Pankow, took courses in Personal Development and Administrative Support, and attends the Administrative Professionals Retreat each year. Thus just as UW provides many workshops and programs to improve faculty and TA teaching (see section A4 above), it provides for staff enrichment and advancement. The UW bureaucracy is often cumbersome and slow, but its heart is clearly in the right place.

Section D: Relationships with other units

In what ways do you collaborate with units at other institutions or at the University of Washington? What are the impacts of these collaborations? Do members of your unit engage in or have opportunities to engage in interdisciplinary research? Do ties to other units or other kinds of interdisciplinary opportunities aid you in recruiting new faculty and graduate students?

UW is a highly collaborative research environment as detailed in sections A1a, A1c1, A1c2, A2, B2, C5, and F1a. Our department already participates in 3 (soon 4) interdepartmental and interdisciplinary graduate programs (BMSD, MCB, Neurobiology and Behavior [NeuBeh], and soon the Molecular Medicine Training Program [MMTP, see section F1a]; many of our graduate courses are already "conjoint", meaning they are taught by faculty from multiple departments; and most of our faculty have active research collaborations with other UW faculty both within and outside the department. In addition, the chairs of all the basic science departments at the medical school together constitute the Basic Science Heads Committee, which meets monthly with John Slattery, Vice Dean for Research and Graduate Education, to air (if not decide) issues of common interest ranging from graduate stipends to animal care to RCR distributions.

There is an expectation of faculty participation in the governance of the Department, the College or School, and the /University. How do faculty members within your unit meet this expectation? How is participation in shared governance encouraged and valued?

Department committees. We have a Graduate Admissions Committee (chaired by Jim Hurley), a Seminar Committee (chaired by Tamir Gonen), and a Schultz Fellowship Committee (chaired by Dave Morris) which supports graduate students in the broad area of cancer research (depts.washington.edu/biowww/gradprogram/schultz.html); however, the current chair is not a believer in the proliferation of committees for every purpose. For example, the department previously had an Appointment and Promotions Committee which reviewed the credentials of every candidate for appointment and promotion, and presented the case in writing to the full department for a vote. The current chair does not see the purpose of an intermediary committee when the candidates are already familiar to all the faculty in our relatively small department. An entire step can be skipped, and a great deal of time saved, by asking a single faculty member who is intimately familiar with the candidate to present the case to the full faculty, followed by a full discussion.

Shared governance. The current chair believes in the power of an open door and open mind policy. I am glad to be interrupted almost any time, and I take all ideas and suggestions seriously. All of us have good and bad ideas, the chair included; ego should not be at stake in any of these decisions — all that matters is the best path forward. Those who feel strongly that something should or should not be done, or should be done differently, do not hesitate to show up at my door without appointment (either individually or occasionally in small groups) and I almost always hear them on the spot. Sometimes the other point of view is self evidently right; other times, it may take a bit of discussion or even a period of reflection for me to come round to a different point of view; sometimes, I simply disagree and am careful to explain why; and sometimes, I take the issue to a full faculty meeting after all. As mentioned above, most faculty seem to appreciate how much time is saved by not meeting as a faculty about every single issue. Although a few faculty seem to feel that democracy requires a greater investment of time, my view is that collegiality is more important than a civics lesson version of democracy; as long as competing points of view are heard and taken seriously, minor issues can be expedited and serious issues flagged early.

Section E: Diversity

We make a serious effort to recruit a diverse graduate student body, but the current pipeline is small, the competition for qualified candidates fierce, and Seattle is not always perceived as a good home for African-Americans, Hispanics, or Latinos despite the area's progressive reputation. Our January 8, 2008 Faculty Meeting with Karlotta Rosebaugh (Director, Health Sciences Minority Student Programs), Emile Pitre (Associate Vice President, Office of Minority Affairs), and Sibrina Collins (Director of

Graduate Diversity Recruiting, UW Graduate School) suggests that our best bets are to (1) promote biochemistry among freshmen/women biology and chemistry students whose love of science could lead to a fascination with the chemical basis of life; and (2) cultivate pipelines from historically black undergraduate colleges (HBCs) or colleges with large populations of underrrepresented minorities. See section G1 on graduate student recruiting, and Appendix P for the University/Graduate School report on ethnicity and gender distribution for partial answers to the following questions.

Section F: Degree Programs

F1a. Describe the objectives of your doctoral degree program(s) in terms of student learning and other relevant outcomes, as well as its benefits for the academic unit, the university, and region. Compare your objectives with those for programs at institutions you think of as peers.

The objectives and design of our graduate program have been quite conventional for many years but no different in this respect from our peer graduate programs (Appendix Q). Our students choose 3 rotations during the first year, an assortment of courses, and are required to take 3 quarters of literature review to strengthen critical reading skills. Students choose a mentor at the end of the first year, begin thesis research, and a choose a thesis committee with advice from the mentor. After 2 quarters of teaching as a TA in the second year, students spend full time on thesis research, with goal of defending in the 5th year. To take fullest advantage of the advice and wisdom of the thesis committee, we encourage students to take their "General Examination" (conferring formal "admission to candidacy") as early as possible, preferably at the end of the second year, based on proof of principle that the thesis project is probably doable, rather than on data showing that it is largely done. The greatest potential change in our graduate program comes from the new Molecular Medicine Training Program (MMTP) described next, which is designed to help a new generation of basic scientists better understand the complex relationship between basic science and medical care.

The Molecular Medicine Training Program (MMTP). The distance "from bench to bedside" is greater than most students and faculty realize. One of the grand challenges for graduate education in the biomedical sciences is to establish programs and courses that help to make the mantra a reality. Molecular medicine is an interdisciplinary approach to human biology that integrates and applies advances in the basic biomedical and genomic sciences and in biotechnology to the understanding, diagnosis and treatment of human disease. The Molecular Medicine Training Program (MMTP) at the University of Washington is designed to train PhD candidates to use advances in basic sciences to solve problems relevant to human disease; and, conversely, to use insights from human disease processes to solve fundamental biological problems. Training in Molecular Medicine incorporates three key elements: case-based courses, clinical exposure, and dual mentorship of doctoral research. The MMTP is open to graduate students in Ph.D. programs in the Departments of Biochemistry, Bioengineering, Genome Sciences, Immunology, Microbiology, Pathology, Pharmacology, Physiology & Biophysics, and in the interdisciplinary Molecular and Cellular Biology Program. The MMTP is directed by Nancy Maizels (joint in Biochemistry, primary in Immunology) who is also in charge of our introductory biochemistry series for first year medical students (HUBIO 514/524). Other faculty overseeing MMTP come from the many participating departments, as more fully described on the website (depts.washington.edu/molmed/).

The program is well underway with a $5,000,000 award from the HHMI Med into Grad Initiative (www.hhmi.org/grants/institutions/medintograd.html) and aims to become a PhD granting program like MCB, BMSD, and NeuBeh (Neurobiology and Behavior) by 2010. The program currently offers four core courses: Molecular Medicine (CONJ 514A/B), Challenges in Molecular Medicine (Conj504), Clinical Medical and Human Genetics (CONJ 513), and Molecular Basis of Disease (PATH 500). Of these, "Challenges in Molecular Medicine (CONJ 504)" is especially notable because it asks why certain diseases have proved refractory to treatment despite the concerted efforts of basic scientists and clinicians alike, and huge investments of funding. We all claim to learn from experience, but seldom make a formal effort to do so.

University of Washington ranks first among public universities and second among all US universities in federal research funding, but has fewer graduate students in biomedical sciences than many other universities. There has been talk for many years about expanding the Molecular and Cellular Biology (MCB) Graduate Program (section B2), but the MCB Steering Committee and MCB students both feel that the resulting loss of intimacy would endanger the educational experience. The MMTP may help to redress this imbalance, and point the way to a future in which basic science and clinical departments collaborate to train a new generation of graduate students with a more realistic appreciation of the role of research in health care (see HHMI Abstract in Appendix C).

F1b. Describe the standards by which you measure your success in achieving your objectives for doctoral program(s). Using these standards, assess the degree to which you have met your objectives. Indicate any factors that have impeded your ability to meet your objectives and any plans for overcoming these impediments.

See section F3e and Appendix E.

F1c. How do you inform your students of and prepare them for the breadth of opportunities and career alternatives available within and outside of the academy? This would include careers in industry, for instance, as well as academic careers in institutions other than research-intensive universities.

Our undergraduate advisors maintain a "Grad Student Career Resources" website (depts.washington.edu/chem/grad/career.html) which links to the Center for Career Services; American Chemical Society (ACS) Career Services; Alternative Careers — a guide to traditional and alternative careers in science; Job Opportunities in government, industry, biotechnology, nanotechnology, and academia; and Job Resource — a job listing engine with positions in private and public organizations nationally.

F1d. How are you staying informed of the career options that graduates of your program typically pursue and the success they are obtaining? How are you using this information in departmental planning?

See section F3e.

F2. Master's degrees (if applicable, as separate from Doctoral degrees)

We do not offer a Master's degree except for graduate students who have done well in the first year of graduate study but are unable to complete the doctoral degree.

F3a. Bachelor's degrees

The BS in Biochemistry. The objective of our BS program is to prepare students for careers in the biomedical sciences and chemical biology; medicine, nursing, dentistry, and pharmacy; and allied fields such as microbiology, fisheries, forestry, oceanography, neurobiology and behavior, and psychology where a knowledge of the chemistry of life processes may be useful or essential. The curriculum requirements from our website (www.washington.edu/students/gencat/academic/biochem.html#UNDER) and a model undergraduate schedule (depts.washington.edu/chem/undergrad/degreereqs.html) are attached as Appendix R.

Learning objectives and expected outcomes. At the conclusion of their studies, graduating biochemistry majors should possess a general working knowledge of the basic areas of biochemistry; be proficient in basic laboratory skills; have the ability to carry out strategies for solving scientific problems; have an understanding of the principles and applications of modern instrumentation, computation, experimental design, and data analysis; have had the opportunity to gain experience with a research project; have the ability to communicate scientific information clearly and precisely; have the ability to read, understand, and use scientific literature; have an awareness of the broader implications of biochemical processes; have had the opportunity to work as part of a team to solve scientific problems; and have had an introduction to opportunities in, and requirements for, the careers available to biochemistry majors. [Text quoted from www.washington.edu/students/gencat/academic/biochem.html#under]

Proposed bachelor of arts in biochemistry. We are in the process of creating a bachelor of arts degree in Biochemistry. The Department has been given "permission to develop" status from the Washington State Higher Education Coordinating Board (HECB) with final approval of the degree contingent on HECB approval. The proposed BA in Biochemistry would be designed for students who are interested in studying biochemistry, but are seeking a broader educational experience than is practical given the extensive upper-division lecture and laboratory requirements of the existing bachelor of science degree. The BA in Biochemistry would require 180 credits (the BS in Biochemistry requires 196 credits) involving a variety of elective courses in related sciences, history, and public policy. The BA would also help a small number of capable students who fail to achieve the high academic standards required for a BS in Biochemistry. These students are currently diverted to the BA in Chemistry, but at a late stage in their undergraduate careers; it would make far more sense for these students to complete the proposed BA in Biochemistry. We had hoped to have the BA in place before autumn quarter 2007, but the Faculty Comittee on Academic Standards was overwhelmed and March 2008 is now the expected approval date. We have several students in the wings waiting to graduate with this degree once approval comes through, hopefully before graduation this spring. [Adapted from text by Lani Stone, Academic Advisor, Department of Chemistry, in the Winter 2007 issue of the Transfer eNewsletter]

F3b. Describe the standards by which you measure your success in achieving your objectives for undergraduate programs. Using these standards, assess the degree to which you have met your objectives.

Measuring undergraduate success. The Biochemistry major attracts very talented undergraduates. Our majors won the UW President's Medal in both 2006 and 2007 (Sariah Khormaee and Minh-An Nguyen respectively), and a Dean's Medal in 2005

(Jared Silvia). These are not small accomplishments in a state school with 28,000 undergraduates. Our major is also growing very rapidly — with 113 graduates in 2004-05, 146 graduates in 2005-06), and 162 graduates in 2006-07 — always about half men and half women. We are delighted with the gender balance, but worried about an increase of >40% in majors since 2005 (also see Appendix P). Growth testifies to our success, but where will it end?

We are also concerned about the dearth of African Americans, Latinos, and Native Americans (Appendix P) although, as a major that stands on the shoulders of giants, it is not immediately clear what we as a department could do to improve this situation. One possibility is to redouble the efforts we already make to encourage our majors to enjoy an undergraduate research experience in our department (BIOC 499, as described in section B4 and documented in Appendix L). Another possibility would be to make friendly presentations to freshmen/women or sophomores interested in biology, chemistry, microbiology, and allied fields explaining the pleasures, possibilities, and requirements of the biochemistry major; otherwise, undergraduates do not see us as we see ourselves until the introduction to biochemistry in junior year (BIOC 405/406 or the BIOC 440/441/442 series).

F3c. In what ways have you been able to involve undergraduates in research programs in your unit? How do you assess the results? What other teaching innovations have your faculty undertaken or are your faculty considering?

See sections A4, B4 and Appendix L.

F3d. Indicate the steps the unit has taken to comply with state-mandated accountability measures (i.e., reduced time to degree; increased graduate efficiency index; increased retention rate). Have these steps improved the quality of student learning in your program? Why or why not? Do you envision any further steps to increase compliance with state-mandated accountability measures?

Our Biochemistry major (like those everywhere else) stands on the shoulders of giants: Students must take Math, Physics, Biology, and both introductory and organic Chemistry before their first formal biochemistry course in their junior (or even senior) year. The unfortunate consequence was that our BS degree in Biochemistry required 196 credits, leaving little time for the intellectually broadening or interdisciplinary studies that are supposed to be a part of undergraduate education at a great university. We also provided no fallback position for BS majors whose interest in biochemistry had wained, or who found the major more difficult than anticipated. As described above, the proposed BA degree program directly addresses and should solve these problems. We also plan a new Catalyst-based exit interview to systematically gather information about what our graduates would have liked us to do differently.

F3e. How are you staying informed of the career options that graduates of your program typically pursue and the success they are obtaining? How are you using this information in departmental planning?

Most of our graduate students continue on to postdoctoral positions, occasionally in Seattle and most often elsewhere; very few go directly to employment outside the academy (Appendix E). We do not systematically track our graduates, but rather depend on former mentors to remain in touch. With NIH funding alternately hopeful or hopeless, and the biotech industry alternately expanding and contracting, we cannot fine tune our program to match changing perceptions of the world beyond J- and K-wing. We can only hope that high visibility publications, foresighted education such as the new Molecular Medicine Training Program (section F1a), and solid teacher training will help our graduates to compete for the positions they want in the life sciences sector, the academy, or elsewhere.

Section G: Graduate Students

G1a. Recruitment and retention

Graduate recruitment and retention overview. The students who apply for graduate study in our department generally have good to very good test scores and GPAs, but are seldom the very best (Appendix S). Thus we tend to look for prior laboratory experience, evidence of experimental motivation and success, and very strong letters of recommendation; in short, our recruiting strategy is to look for "diamonds in the rough." This strategy, although born of necessity, actually gives us considerable freedom in looking for underrepresented groups.

Graduate student recruiting is an unavoidably expensive process in the basic biomedical sciences. Universally, students are flown in from their undergraduate institutions or current place of residence (we pay only domestic airfare, never international); put up for two days and nights at a pleasant local hotel; and then wined and dined each evening while the days are filled with talks, tours, and interviews with individual faculty. A few weaker students must go to the trouble of selling themselves to us, but most students we invite are sufficiently strong that *we must sell ourselves to them*. The two day visit must therefore be carefully choreographed from beginning to end; graduate students and faculty alike must put on a brave face; and all hands must be on deck for any unexpected mishaps. We estimate the per capita cost of Visiting Day at $900 which breaks down into $500 airfare, $200 hotel, and $200 food including the Friday buffet dinner at home of the Chair Alan Weiner and his wife Professor Nancy Maizels (Immunology, joint with Biochemistry), and the local activities on Saturday (hiking, city tour, ferry ride, etc.) hosted by our current graduate students. Any attempt to trim the recruiting budget reduces our yield of students, so we must grin and bear it.

With a target entering class size of 4 to 6, we have typically invited 25 to 30 students each year, at a total cost averaging $25,000 annually. All remaining expenses are borne by the departmental research cost recovery budget (RCR) and our limited discretionary budget. We also used departmental funds exclusively for diversity outreach such as our presence at the ABRCMS Conferences in 2006 and 2007, and our contribution to the UW SOM presence at the 2007 SACNAS Conference (see below).

We are especially grateful that the Graduate School has allowed graduate stipends in the biomedical sciences to rise with those of our peer institutions; this keeps us competitive, and enables us to compete based solely on quality without resorting to financial inducements. We are also grateful for a Graduate School Fund for Excellence and Innovation (GSFEI) Top Scholar Award (curently $6,900) which covers about 30% of our total graduate recruiting costs.

Increasing graduate student diversity. We have been moderately successful in recruiting a diverse graduate student body (see Appendix T), and we are constantly trying to improve our recruitment efforts by every strategy we can think of:

• We have worked closely with Dr Sibrina Collins (Director of Graduate Diversity Recruiting, UW Graduate School) who has given us the names of minority candidates with interests in the general area of basic biomedical sciences. As chair, I have then written warm, informative emails encouraging them to investigate our program and apply (Appendix U). In some cases where their professed interests were broad, I have not tried to sway them toward our department, lest this interfere with the real goal of interesting them more generally in biomedical or scientific research at UW as a whole (also see Appendix U for an example of a more inclusive email).

• We have sought out students ourselves. Professor David Kimelman attended the 2005 Annual Biomedical Research Conference for Minority Students (ABRCMS) in Atlanta, our Graduate Program Assistant Kelley Pankow (formerly Riek) attended the 2006 ABRCMS, and this past year Professor William Parson and Ms Pankow jointly attended the 2007 ABRCMS in Austin. Also, as Principal Investigator of a large and longlived NIH training grant (5T32GM007270-33, Training In Molecular And Cellular

Biology) Professor Kimelman has played a major role in minority outreach and has committed training grant funds for that purpose.

• Most recently, we invited Karlotta Rosebaugh (Director, Health Sciences Minority Student Programs), Emile Pitre (Associate Vice President, Office of Minority Affairs), and Sibrina Collins to our January 8, 2008 Faculty Meeting which was devoted to an informational session followed by collective brainstorming about the many programs and, approaches for minority recruiting at the graduate level and how we might redouble our efforts.

• We have also tried to establish new channels for recruiting minority graduate students. Sibrina Collins recommended Professor Lance Shipman of the Department of Chemistry at Morehouse College in Atlanta (a historically black college) as a good contact who was interested in placing talented undergraduates in receptive graduate programs. Professors David Kimelman and Brian Kennedy invited Shipman, and he visited for a full day with our faculty (May 31, 2007) and presented a regular department seminar on own research ("Structure and function of 4'-phosphopantetheine transferases"). Shipman also brainstormed with many of us concerning best strategies for minority recruiting, and how we might deal with the potential showstoppers: distance from family, culture shock, and fear of the unknown.

• Finally, we have scattered instances of minority students in our research groups: Ke'Anna Brown, a minority high-school student from Virginia, carried out an independent research project with Professor William Parson in the summer of 2001 with support from the MARC (Minority Access to Research Careers) Program. She is now a senior at Trinity University and is applying for admission to PhD programs in immunology at several first-rate schools. Professor Wim Hol mentored a Hispanic minority graduate student (Marissa Yanez, educated at UC Berkeley, PhD 2007) originally recruited by Bioengineering. Professor Stephen Hauschka has had several minority undergraduates in his research group who have gone on to biomedical graduate work, most recently a superb African-American Faysal Dahir who took the

Biology 200 course taught by Hauschka, participated in the 2006 HHMI Exceptional Research Opportunities Program (EXROP), and just graduated as a Bioengineering major.

G1b. What are your retention rates for master's and doctoral programs? To what do you attribute attrition? What steps are taken to minimize attrition?

See Appendix E. Of 19 PhD graduates during 2005-2007, 13 are currently postdoctoral fellows, 1 is a medical resident, 1 is completing the MD of our MD/PhD (MSTP) program, 1 works for the Department of Defense, and 3 unknown; of 2 MS graduates during the same period, 1 is a homemaker and 1 unknown.

G2a. In what ways do you communicate academic program expectations to students? Such information should include: timelines, phases and benchmarks of the degree program; procedures for committee formation; coursework, exam and presentation requirements; and standards of scholarly integrity.

The departments Graduate Program Adviser (GPA, currently Jim Hurley) has primary responsibility for tracking graduate student progress during the first year. Once the mentor is chosen in early June, the mentor assumes these responsibilities with the GPA available for consultation.

G2b. In what ways do you inform students of your unit's graduation and placement record? Such information should include time to degree; average completion rates (Master's and Ph.D.); and employment of graduates two and five years after degree completion.

See section F3e and especially section G2d for our departmental sponsorship of graduate student-initiated lecture/discussion series such as "What can you do with a PhD in the biological sciences?" (now the "Bioscience Careers Seminar Series") and the Forum on Science Ethics and Policy (FOSEP).

G2c. Please attach an example of your departmental mentoring/advising plan. Such information should include evidence that each students' work and progress are being evaluated on at least an annual basis and that the results of the evaluation are communicated to the student.

See Appendix Q for a complete description of our graduate program, including consultations with the Graduate Program Advisor during the first year regarding potential rotations, formation of the thesis committee after the mentor has been chosen in early June of the first year, and annual (or preferably twice yearly) thesis committee meetings. A memo from the mentor to the student, the committee members, and the Graduate Program Advisor summarizes the content and recommendations of each thesis committee meeting.

Responsible Conduct of Science. We are also among the few departments that maintain a separate departmental course in Responsible Conduct of Science (known among our students as "Ethics 101"). All first year graduate students who matriculate through our department or through the interdepartmental BMSD Program (administered by Ms Kelley Pankow, our Graduate Program Assistant) are required to attend all five sessions with discussions led by faculty who have special interests or expertise in the topics: Intellectual property, Ethical considerations in animal and human experimentation, Sharing reagents, Mentoring and record keeping, The review and publication process, and Communicating science to the public. This course formally supplements the School of Medicine Biomedical Research Integrity Lecture Series (depts.washington.edu/mhedept/conedu/bri/index-bri.html) but our feeling is that the immediacy of discussing these issues with our own students brings the subjects alive, and assures that the issues are on the table within the department. Also see section G2d below for the FOSEP lecture series, which can be viewed as continuing education in the many nonscientific dimensions of science.

G2d. Please attach a copy of your professional development plan. Such a plan should address questions such as: "What are the career opportunities for a master's or Ph.D. graduate in your field?" "What skills/experiences contribute to success in the various academic and non *academic career paths listed above?" Include information on conferences students are encouraged to attend and how they are prepared for the experience.*

Graduate professional development. We do not have a professional development plan within the department; however, our department was a founding sponsor and contributor ($1,000) in 2001 to a lecture and discussion series, initiated and organized biomedical graduate students, and entitled "What can you do with a PhD in the biological sciences?" This well received program brought outside speakers from industry, government, the media, schools, etc. to present and then discuss alternative careers over a pizza dinner. After 2 years running (literally), the student organizers were overwhelmed by the effort required to sustain a successful lecture series, and the program was taken over in 2003 by the Office of Research and Graduate Education in the School of Medicine. Although soberly renamed the "Bioscience Careers Seminar Series," it continued to bring in speakers on similar topics, and continued to survive on departmental contributions (including ours). Among the topics: Careers in Undergraduate Education, Business Development in the Biotech Industry, From Government Postdoc to Medical Science Liaison, Translating Lab Experience into the Business World, When Worlds Collide: Science Journalism, The Realities of Forensic Chemistry and DNA Analysis, and Networking Your Way into Non-Traditional Careers. Soon thereafter in 2004, graduate students and postdocs at UW and Fred Hutchinson Cancer Research Center organized and raised funds (including ours) to create the Forum on Science Ethics and Policy (FOSEP) whose mission is to "stimulate dialogue among scientists, policy makers, and the general public in the Puget Sound Region about the impact of science and technology in our society." FOSEP speakers have addressed timely and controversial issues of science policy such as embryonic stem cells, intelligent design, climate change, and internet neutrality.

G3a. In what ways do you include graduate students in the governance of your department?

Graduate participation in governance. An elected graduate student representative is welcome to attend our faculty meetings but must leave if we are discussing our first year students at the conclusion of the spring quarter, or any individual student at any other time. Student opinions are incredibly valuable because what students are actually thinking can be totally different from what the faculty *imagine* students are thinking. However, a single student representative, no matter how impartial or well informed, cannot speak for all students; so we remain dependent on the open atmosphere in our department which encourages students and faculty to talk freely.

Graduate students go to lunch with our job candidates, and provide feedback. Although faculty may be a better judge of longterm success, the most critical part of student reaction is also the most straightforward: Would they consider choosing the candidate as a mentor? No use hiring someone who scares off potential graduate students or fails to excite them.

Perhaps the single most important contribution of graduate students to departmental governance is helping to match TA positions with TA volunteers (see section B2 and Appendix M) who come from the Biochemistry Graduate Program, the BMSD Program (Biomolecular Structure and Design), and the MCB Program (Molecular and Cellular BIology). The quality and enthusiasm of the TAs helps to determine the success of our courses, and matching students to courses is no simple matter.

Finally, the chair frequently consults the most mature, balanced, and interactive members of our graduate program for advice on all matters both departmental and academic. I never summon a student to my office, or schedule an appointment; I go to their lab bench, and chat with them in plain sight and within hearing of anyone else who happens to be around. I want it to be clear that we may have disagreements in the department, but we (generally) do not have secrets, and all opinions matter especially those of the students.

G3b. Please describe your grievance process and characterize the nature of any grievances that have been lodged over the past 3 years. If the characterization is likely to reveal any *students' identities, please address this issue in a separate but accompanying document addressed to the Dean of the Graduate School.*

We do not have a formal grievance procedure, nor have any grievances arisen since 2000 to my knowledge. Any potential problems would be resolved by discussions with the Mentor, the Graduate Program Advisor (formerly Steve Hauschka, now Jim Hurley), or the chair.

G4. For graduate student service appointees, please describe: a. Appointment process; b. Average duration of appointment; c. Mix of funding among the various appointments (teaching, research and staff assistantships, fellowships, traineeships); d. What criteria do you use for promotions and salary increases?; e. In what ways are graduate student service appointees supervised?; f. What training do graduate student service appointees receive to prepare them for their specific role?

All students except those on personal fellowships (NSF, HHMI, etc.) are fully supported by the department or the mentor at the level established by the Graduate School. Support includes tuition and generous health insurance but not the student Services and Activity Fee (gym, etc.) or UAW dues. We require at least two full quarters of substantial teaching, usually in the second year, and usually in a large lecture course (BIOC 405 series, BIOC 440 series) or the BIOC 426 laboratory. In our view, teaching is not a service, and is not compensated separately, because it is an essential component of graduate education and is required as part of the graduate curriculum.

Appendix A

Graduate Student Statistical Summary * The Graduate School * University of Washington Printed: 21-Nov-06

Biochemistry

Y	1997-98	1998-99	1999-00	2000-01	2001-02	2002-03	2003-04	2004-05	2005-06	2006-07
Autumn Quarter Enrollment										
Enrollment History										
Total	41	47	48	46	45	43	44	46	44	46
Full-Time	41	47	48	45	44	42	42	45	44	46
Part-Time	0	0	0	1	1	1	2	1	0	0
Male	22	25	29	29	29	28	29	34	34	36
Female	19	22	19	17	16	15	15	12	10	10
Ethnic Minority	1	4	3	3	5	6	6	4	5	5
International	8	10	12	11	10	13	12	14	14	11
Wash. Resident	22	27	30	25	26	22	24	22	20	24
Non-Resident	19	20	18	21	19	21	20	24	24	22
New Student Enrollment	9	5	6	8	7	4	9	7	6	5
Continuing	32	42	42	38	38	39	35	39	38	41
Annual Applications (Sum-Spr qtrs)	73	75	96	73	81	95	105	107	77	
Autumn Quarter	71	74	95	72	80	95	103	107	76	95
Autumn Quarter Denials	39	56	64	52	47	71	78	78	58	78
Autumn Quarter Offers	26	15	22	18	21	22	17	14	16	17
Autumn Quarter Percentages										
% Denied (of Applications)	54.9%	75.7%	67.4%	72.2%	58.8%	74.7%	75.7%	72.9%	76.3%	82.1%
% Offers (of Applications)	36.6%	20.3%	23.2%	25.0%	26.3%	23.2%	16.5%	13.1%	21.1%	17.9%
% New Enrollees (of Apps)	12.7%	6.8%	6.3%	11.1%	8.8%	4.2%	8.7%	6.5%	7.9%	5.3%
% New Enrollees (of Offers)	34.6%	33.3%	27.3%	44.4%	33.3%	18.2%	52.9%	50.0%	37.5%	29.4%
Autumn Minority Admissions										
Application	7	15	13	11	18	11	10	19	13	9
Denials	6	11	9	8	11	6	9	14	10	8
Offers	0	4	4	3	7	5	1	1	3	1
Autumn International Admissions										
Application	8	14	16	18	25	36	30	27	17	24
Denials	5	12	13	15	18	33	29	24	14	23
Offers	2	1	0	2	5	2	0	1	3	1
Applicant Average GPA										
Denied	3.38	3.34	3.43	3.52	3.39	3.51	3.51	3.45	3.47	3.52
Accepted But Not Enrolled	3.68	3.47	3.52	3.70	3.60	3.39	3.59	3.60	3.59	3.58
Accepted and Enrolled	3.75	3.60	3.24	3.64	3.48	3.39	3.50	3.64	3.38	3.50
Applicant Average GRE										
Denied										
Verbal Score	540	529	549	498	495	509	555	540	515	527
Quantitative Score	664	680	705	696	667	705	724	725	706	730
Analytical Score	648	628	662	669	644	658	667	667	654	
Accepted But Not Enrolled										
Verbal Score	595	592	594	595	557	560	606	608	581	581
Quantitative Score	703	692	731	723	735	732	726	758	746	738
Analytical Score	688	722	697	701	702	726	636	800	728	
Accepted and Enrolled										
Verbal Score	577	583	622	643	508	598	650	618	583	608
Quantitative Score	684	663	748	722	720	708	732	773	715	742
Analytical Score	668	687	724	658	676	658	683	800	727	
Annual Degrees (Sum-Spr qtrs)										
Masters:		1			2			1	1	
Doctoral:	6	6	6	8	10	10	4	6	7	
Ph.D. Candidates:	9	9	10	5	7	5	8	7	6	
Autumn Quarter Financial Support										
Teaching	8	0	0	0	0	0	0	0		0
Research Assistants	27	39	38	39	44	40	43	44	43	45
Fellowship	1	5	4	4	1	0	0	1		0
Traineeships	15	16	17	14	9	8	11	9	8	12

Appendix B
Academic Unit Profile

	FY06	FY 07	FY 08	
Revenue				
Faculty salaries (A -component or "state line")	1,723,057	1,891,066	1,881,902	
Staff salaries (UW contribution)	142,718	146,790	147,036	
Graduate student support (UW contribution)	207,330	212,724	212,724	
Operations (UW contribution)	(16,780)	(16,511)	(13,152)	
Operations (from restricted gifts)	256,008	276,504	307,542	(estimated)
Research cost recovery (department share*)	688,776	611,598	664,435	
Grant support	17,673,731	23,646,862	20,000,000	(estimated)
Total	20,674,840	26,769,033	23,200,487	
Selected expenses				
Faculty salaries (B-component from grants)	484,556	488,382	535,068	
Graduate student support (total)	1,694,523	1,707,781	2,052,436	

* RCR is based upon expenditures in prior fiscal year

Appendix C
Special pathways, options, or certificates within PhD program

Molecular Medicine Graduate Certificate Program

The Graduate Certificate Program in Molecular Medicine will provide training that integrates fundamental principles of biology with human health and disease; that provides exposure to the concepts and practice of medicine through participation in a clinical rotation in human genetics or a medical pathology course; and that emphasizes the importance of and opportunities for translational research by dual mentorship of trainees by a basic scientist and a clinical/translational mentor. Students in this Program must fulfill requirements of the home department or interdisciplinary program, meeting the standards of that department or program, and also fulfill specific requirements of the Molecular Medicine Program.

Rationale and History

Molecular Medicine is a recognized area of excellence at the University of Washington. This reflects an institutional culture that encourages interdisciplinary science and translational research. Many of the best applicants and trainees in University of Washington Ph.D. programs in the basic sciences express a strong interest in questions related to human health and disease, and most matriculate in Ph.D. training programs with the intention of working on aspects of biomedical research that relate to human health and disease. Biomedical science Ph.D. programs at the University of Washington have met part of this trainee interest by providing exemplary training in a wide range of basic science disciplines related to medicine. What has been lacking is a complement to this strong basic science training that provides a coherent training experience designed to prepare Ph.D. trainees to carry out research on problems relevant to human disease, in a clinical setting or as part of an interdisciplinary research team that includes both physicians and basic scientists. The Molecular Medicine Program is designed to provide that complementary expertise and experience.

The Molecular Medicine Training Program combines coursework, participation in clinics, and dual mentorship by a basic scientist and a clinically- trained or clinically-oriented research mentor. It was developed by a highly interdisciplinary group of faculty representing basic science departments and clinical departments from across the University of Washington Schools of Medicine and Engineering. The program also sponsors public lectures on topics of current biomedical interest (see below)

Molecular Medicine Certificate Training was approved by the UW Board of Regents in November, 2005. Certificate Training is open to eligible students who entered in Fall, 2003 and thereafter.

molecularmedicine

Wednesday Public Lecture Series

12.5.2007 Kane Hall 220 7:30 pm	**Evan Eichler, Ph.D.** HHMI Associate Investigator, UW Department of Genome Sciences **The Changing Human Genome: Implications for Disease and Evolution**
2.6.2008 Kane Hall 210 7:30 pm	**Wesley Van Voorhis, M.D.** Professor, UW Departments of Medicine & Pathobiology **Malaria: Hot times for a bad disease**
3.12.2008 Kane Hall 220 7:30 pm	**Gerald Nepom, M.D., Ph.D.** Director, Benaroya Research Institute at Virginia Mason; UW Department of Immunology **Diabetes**
4.9.2008 Kane Hall 220 7:30 pm	**Denise Galloway, Ph.D.** Head, Cancer Biology Program, Fred Hutchinson Cancer Research Center; UW Department of Microbiology **HPV and Cervical Cancer: 25 Years from Discovery to Vaccine**
5.7.2008 Kane Hall 220 7:30 pm	**Paul Yager, Ph.D.** Professor and Acting Chair, UW Department of Bioengineering; Departments of Chemistry, Chemical Engineering, Oral Biology **Point of Care Diagnostics for the Developing World**

The University of Washington Molecular Medicine Program and this series are supported in part by the Howard Hughes Medical Institute.